

CASTENMILLER ET AL. -- 09/739,622

Client/Matter: 081468-0275503

a position measuring device comprising:

a radiation source mounted on said reference frame;

a two-dimensional radiation detector mounted in a fixed position on said reference frame; and

a mirroring device mounted on one of said object tables that is moveable relative to said reference frame so as to reflect radiation emitted by said radiation source toward said radiation detector, wherein the radiation source and the two-dimensional radiation detector are mounted to the reference frame so that a radiation beam from the radiation source is incident at a predetermined angle relative to the movable object table and the predetermined angle is 45°.

2. (Original) Apparatus according to claim 1 wherein said radiation source is a source of collimated radiation.

3. (Previously presented) Apparatus according to claim 1 wherein said radiation source is a source of monochromatic radiation.

4. (Previously presented) Apparatus according to claim 1 wherein said mirroring device is a retro-reflector.

5. (Previously presented) Apparatus according to claim 1 wherein said radiation source comprises a light source mountable away from the reference frame, beam directing optics mountable on said reference frame and an optical fiber to couple said light source to said beam directing optics.

6. (Previously presented) Apparatus according to claim 1 wherein said radiation source comprises one of a laser diode and an LED as a light source.

7. (Previously presented) Apparatus according to claim 1 wherein said two-dimensional position detector is a two-dimensional PSD, or a CCD camera, or a four quadrant photo-detector.

8. (Previously presented) Apparatus according to claim 4 wherein said retro-reflector

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comprises a trapezoid form of a material transparent to said radiation and having three mutually perpendicular surfaces meeting at a corner, said three surfaces being provided with a reflective coating.

9. (Previously presented) Apparatus according to claim 4 wherein said retro-reflector comprises a convergent lens and a reflective surface, said reflective surface being spaced a distance from said lens equal to the focal length of said lens.

10. (Previously presented) Apparatus according to claim 1 comprising three position measuring devices as therein defined.

11. (Currently amended) ~~Apparatus according to claim 1 further comprising A~~  
lithographic projection apparatus comprising:  
a projection beam illumination system which supplies a projection beam of radiation;  
a first object table for holding a protection beam patterning device which patterns the  
projection beam according to a desired pattern;  
a second object table for holding a substrate; and  
a projection system which images the patterned beam onto a target portion of the  
substrate;  
a reference frame; and  
a position measuring device comprising:  
a radiation source mounted on said reference frame;  
a two-dimensional radiation detector mounted in a fixed position on said  
reference frame;  
a mirroring device mounted on one of said object tables that is moveable relative to  
said reference frame so as to reflect radiation emitted by said radiation source toward said  
radiation detector; and  
an incremental position sensing device to detect a position of said moveable object table in a detection range wider than that of said position measuring device and a combiner, which combines output signals from said incremental position sensing device and said position measuring device to determine an absolute position of said object table in said detection range.

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12. (Currently amended) A method of manufacturing a device comprising:  
providing a substrate provided with a radiation-sensitive layer to an object table;  
providing a projection beam of radiation using an illumination system;  
patterning the projection beam to form a pattern in its cross section; and  
projecting the patterned beam onto said target portions of said substrate;  
determining a reference position of said object table relative to a reference frame by:  
emitting radiation from a radiation source mounted on said reference frame  
toward a mirroring device mounted on said object table;  
reflecting the radiation; and  
detecting the reflected radiation in a two-dimensional radiation detector  
mounted in a fixed position on said reference frame, wherein the radiation source and the  
two-dimensional radiation detector are mounted to the reference frame so that a radiation  
beam from the radiation source is incident at a predetermined angle relative to the object  
table and the predetermined angle is 45°.
13. (Previously presented) A method according to claim 12 further comprising:  
determining an absolute position of said object table by measuring movements thereof  
relative to said reference position using an incremental position sensing system.
14. (Previously presented) A device manufactured according to the method of claim 12.
15. (Currently amended) A position measuring device comprising:  
a radiation source mounted on a reference frame;  
a two-dimensional radiation detector mounted in a fixed position on said reference  
frame; and  
a mirroring device mounted on an object that is moveable relative to said reference  
frame so as to reflect radiation emitted by said radiation source toward said radiation  
detector, wherein the radiation source and the two-dimensional radiation detector are  
mounted to the reference frame so that a radiation beam from the radiation source is incident  
at a predetermined angle relative to the object tables and the predetermined angle is 45°.

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16. (Currently amended) A method of determining a reference position of a moveable object table comprising:

emitting radiation from a radiation source mounted on a reference frame toward a mirroring device mounted on said moveable object table;

reflecting the radiation by said mirroring device; and

detecting the reflected radiation in a two-dimensional radiation detector mounted on a fixed position on said reference frame, wherein the radiation source and the two-dimensional radiation detector are mounted to the reference frame so that a radiation beam from the radiation surface is incident at a predetermined angle relative to the object table and the predetermined angle is 45°.

17. (Canceled)

18. (Currently amended) A lithographic projection apparatus comprising:

a projection beam illumination system which supplies a projection beam of radiation;

a first object table for holding a projection beam patterning device which patterns the projection beam according to a desired pattern;

a second object table for holding a substrate; and

a projection system which images the patterned beam onto a target portion of the substrate;

a reference frame; and

a position system including three position measuring devices, each position measuring device comprising:

a radiation source mounted on said reference frame;

a two-dimensional radiation detector mounted in a fixed position on said reference frame; and

a mirroring device mounted on one of said object tables that is moveable relative to said reference frame so as to reflect radiation emitted by said radiation source toward said radiation detector, wherein the three position measuring devices are arranged non-parallel to each other, wherein the radiation source and the two-dimensional radiation detector are mounted to the reference frame so that a radiation beam from the radiation source is incident at a predetermined angle relative to the movable object table and the predetermined angle is 45°.

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19. (Canceled)

20. (Previously presented) Apparatus according to claim 18, wherein the radiation source and the two-dimensional radiation detector of each position measuring device are adjacent to one another.

21. (Previously presented) Apparatus according to claim 1, wherein the mirroring device is configured to reflect the radiation onto a return path parallel to and displaced from an incident path.

22.-23. (Canceled)

24. (Previously presented) A method according to claim 12, wherein reflecting the radiation includes reflecting the radiation onto a return path that is parallel to and displaced from an incident path.

25.-26. (Canceled)

27. (Currently amended) ~~Apparatus~~ A device according to claim 15, wherein the mirroring device is configured to reflect the radiation onto a return path parallel to and displaced from an incident path.

28.-29. (Canceled)

30. (Previously presented) A method according to claim 16, wherein reflecting the radiation includes reflecting the radiation onto a return path that is parallel to and displaced from an incident path.

31.-32. (Canceled)

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33. (Previously presented) Apparatus according to claim 18, wherein the mirroring device is configured to reflect the radiation onto a return path parallel to and displaced from an incident path.

34.-35. (Canceled)